ENERGOPTIONS

OVERVIEW PAPER

AGRICULTURAL SECTOR-

Greenhouses

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1. INTRODUCTION

A wide variety of crops, from vegetables such as tomatoes and cucumbers to ornamentals such as poinsettas, are produced by the commercial greenhouse industry in Canada each year. Many of these greenhouses are operated year-round, while others are used only in the late winter or spring to start bedding plants for later field planting. Maximum yield and health of the crop depends on the greenhouse operator maintaining close control of temperature, ventilation, air circulation, humidity, and in some cases, carbon dioxide levels. This results in high heating and electricity bills (13% of sales is spent on fuel) and requires a significant investment in appropriate heating, air-moving, and control equipment.

Most of the heat demand of a greenhouse occur at night, when heat loss through glazing can be significant. During the day the solar energy falling on the greenhouse is usually sufficient to maintain the required temperatures. In fact, ventilation and/or circulation is often required during the day, even in winter, to prevent temperatures from rising too high and to maintain the required humidity levels. The greatest electrical usage therefore occurs during the day. These heating and electrical peaks mean that large capacity heating equipment and electrical services are required.

Energy and cost savings can be achieved either by reducing the overall heating or electrical load and/or by utilizing some of the excess daytime heat for night-time heating. Further savings can be achieved by substituting an alternative fuel or heat source for the currently used fuel. (Most commercial greenhouses currently use natural gas, oil, or propane for heating.)

This paper presents an overview of energy saving measures which are applicable to commercial greenhouses together with documentation of important lessons learned through their implementation in the past. In particular, the paper highlights the experience gained through several demonstrations supported by the Conservation and Renewable Energy Demonstration Agreements (CREDA) Program. Suggestions for appropriate steps to undertake these measures as well as details on resources available to assist in putting them into practice are presented.

2. OPTIONS

Energy and cost savings can be realized through various energy conservation techniques and/or through installation of alternative heating systems.

. Energy Conservation Techniques

- overall heating and/or electrical load can be reduced through insulation of north walls, multiple glazings, installation of an air-lock entry, insulation and sealing of ventilation fan covers, perimeter insulation, insulated night covers, and daytime shade covers;

- heat pump/heat storage systems can be installed to utilize excess day-time heat gain for night-time heating;

- lower temperature crop varieties can be chosen to reduce heat demand;

- computer control systems and zone temperature control systems can be installed to reduce electrical requirements.

. **Alternative Heating Systems**

- wood-fired boilers and furnaces which use cordwood, wood chips, sawdust, or other wood residue can replace conventional heating systems;

- waste heat available at temperatures above greenhouse requirements can be used directly for heating;

- waste heat or natural heat sources such as ground water or solar energy can be upgraded to greenhouse requirements or otherwise used to reduce heating fuel requirements.

3. CREDA DEMONSTRATIONS

Of these potential energy and cost reduction measures, many were demonstrated through four CREDA projects. All four of the projects provided examples of alternative heating systems for commercial greenhouses--two demonstrated the use of wood, one the use of waste heat for direct heating, and one the use of low temperature waste heat as an insulation barrier. Each of the demonstrations incorporated many of the energy conserving features described above.

A detailed description of each of the four CREDA projects is provided in the ENEROPTIONS Case Studies attached. A brief outline is provided below.

NB 22 Wood-Chip Burner - Brookdale Nurseries, Newcastle, New Brunswick

Wood chips are now being used to fire boilers originally designed for oil at the Brookdale complex which includes greenhouses, retail displays, farmers market, office, maintenance and stock areas. Annual savings of $30,000 in fuel costs have been realized.

ONT 34 Energy from Wood Waste - Foothill Greenhouse Ltd., Kettleby, Ontario

A system which burns wood chips and sawdust provides all heating requirements and results in energy savings of $46,580 annually by replacing oil. Heating, ventilation and humidity are controlled and monitored by a microcomputer, which reduces manpower needs.

SASK 22 Greenhouse Heating Using Industrial Waste Heat - Tri-Co Farms Ltd., Regina, Saskatchewan

Waste hot water from the adjacent oil refinery is used for direct heating of a new 0.4 Ha (1 acre) greenhouse complex. Conventional heating requirements are reduced by as much as 95%, depending on the temperature of the waste water. Crop yields and consumer acceptance are both at satisfactory levels.

NB 44 Surface-Heated Greenhouse Using Waste Heat - N.B. Power, Grand Lake, New Brunswick

A 940 m^2 (0.23 acre) greenhouse adjacent to N.B. Power's Grand Lake Generating Station is heated by waste warm water from the power plant using the surface heating technique. This method of cascading warm waste water over the outside surface of the greenhouse reduced its conventional heating requirements by 30% for an annual savings of $7,000.

Many other greenhouse-related projects have been undertaken. Contact your nearest federal or provincial energy office to learn more about nearby projects or those in applications similar to yours.

4. LESSONS LEARNED

Biomass Heating Systems

Fuel Supply. The practicality and cost effectiveness of alternative heating systems are dependent on local conditions. Wood or other biomass fired systems can only be considered for existing or new commercial greenhouses in areas where sufficient fuel is available. Preparation of the fuel (e.g., chipping) either by the supplier or on-site is another consideration. Availability of supply should be determined in advance and a reliable means of delivering the fuel to the greenhouse should be arranged. Long term supply arrangements should be flexible enough to allow an owner to capitalize on short term options.

Payback Periods. A large capital investment is required to utilize wood or wood waste in a commercial greenhouse operation. Payback periods for a well-designed and well-operated system can be less than 5 years because of the large savings in conventional fuels. The capital cost of the system includes the boiler itself plus an effective fuel storage, feeding and gas cleaning system.

Storage. Careful attention should be given to the sizing of fuel storage facilities. The storage system must be large enough to handle several days' fuel requirements.

Fuel Feed Systems. Similarly, particular care should be taken in designing, operating and maintaining the fuel feed system, as it is the most trouble-prone part of the overall system. Uniform fuel - size, shape, moisture content and cleanliness - is especially important to efficient materials handling. This, in turn, can affect the choice of equipment and thus cost. Note than manually fed systems could be purchased for a much lower price although operation costs would increase.

Expert Advice. For both the fuel storage/feeding system and the boiler, it is necessary to have sound technical advice from an experienced contractor. Any attempt at a do-it-yourself system requires considerable skill on the part of the owner.

Waste Heat Systems

Location of New Greenhouses. Waste heat can only be considered for new greenhouses that can be located adjacent to the waste heat source. The greenhouse should be within 500 m (1,600 ft) of a large source of waste heat such as a power plant, chemical plant or refinery.

Backup system. If a waste heat source is to be used, a full-sized backup system is also required for periods when waste heat is not available.

Payback Period. In areas where oil or propane is used for heating, the extra cost of installing the waste heat equipment can usually be recovered in the form of savings within a period of 5 years.

Water Temperature and Flow. If waste water is to be used for direct greenhouse heating, it should be available above 50°C (120°F) on a continuous basis.

Surface Heating Technique. Waste water available at temperatures below the required inside temperature of a greenhouse can still be economically used for greenhouse heating if the water is cascaded over the outside surface of the greenhouse as an insulating barrier. Local freezing can be avoided when using the Surface Heating Technique by utilizing sufficient water flow and periodic high pressure purging of water headers.

Groundwater-Source Heat Pumps. The use of groundwater-source heat pumps can only be considered where aquifers are of sufficient size. Once again, sound technical advice is necessary prior to installation of a system.

5. NEXT STEPS

If you are considering one of the alternative heating systems described in this ENEROPTIONS package it is important that the following steps be taken:

- Determine as accurately as possible the current heat and electrical consumption of the greenhouse and try to determine the major sources of heat loss.

- Install energy conservation devices and adopt energy conservation measures that will reduce the major heat losses. The actual techniques installed will depend on the type of greenhouse, the crop and the period of the year during which the greenhouse operates. In new greenhouses, incorporate as many energy conservation features into the design as possible.

- If a wood fired boiler is being considered, a reliable long-term supply of wood, wood waste, wood chip or sawdust fuel must be obtained. A written guarantee of delivery and price should be obtained, and the supplier should be ready to enter into a long term contract. An experienced wood burning equipment contractor should also be approached and asked to provide information on wood storage, feeding, and burning equipment and to accurately size the equipment for the reduced heat load. Experience with large scale wood handling equipment is essential.

- If a waste heat source is being considered for a new greenhouse, an accurate estimate of the cost of the additional equipment should be made including any special modifications within the plant providing the waste heat. An experienced consulting engineering firm should be retained for design and economic assessment, and a written agreement made with the plant owner with respect to availability, volume, and temperature of the waste heat stream.

- If capital financing is a problem, then the possibility of innovative financing should be considered. Savings Financing (SF) also known as Energy Management Performance Contracting, is an innovative business arrangement where a significant portion of the project risk, including financial, technical and operating risk, is transferred from the energy user to another party. The firms offering these services, known as Energy Service Companies (ESCo's), typically will carry out walk-through and detailed audits, undertake design and specifications, purchase and install the equipment, maintain and monitor the equipment, and train in-house staff. Since ESCo's intend to recover their investment through the dollar value of the energy savings stream, the provision of quality services is a priority.

6. RESOURCES AVAILABLE

Technical reports are available free of charge for most of the CREDA projects listed above. Addresses of appropriate contacts for follow-up, including equipment suppliers and system designers, are listed at the end of each of the attached ENEROPTIONS Case Studies under the "Further Information" section.

Other information, on alternative heating systems and energy conservation techniques and measures that can be used to reduce commercial greenhouse heating and electrical requirements, can be obtained from provincial Departments of Agriculture and from Agriculture Canada. Examples are "Energy Conservation in Greenhouses" by H.A. Jackson, Agriculture Canada, and "Energy Conservation in Ontario Greenhouses" from the Ontario Ministry of Agriculture and Food.

The departments or ministries of energy in each province or territory have information on energy conservation and may have assistance programs. Check your directory for appropriate contacts.

The Conservation and Renewable Energy Offices (CREOs) of Energy, Mines and Resources Canada in each province and territory have information on federal demonstrations, and other forms of assistance such as technical bulletins on converting to wood and data bases on projects and equipment suppliers. Check the back of the attached file folder for the office in your area.

Information on qualified engineering firms in various areas of specialization and the "Recommended Procedure for the Selection of an Engineer to Provide Professional Services" can be obtained from:

(a) The Association of Consulting Engineers of Canada
Suite 616
130 Albert St.
Ottawa, Ontario
K1P 5G4
(613) 236-0569

(b) The Consulting Engineering Organization in each province.

Information on innovative financing arrangements can be obtained through the above contacts or by contacting:

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(Re: ENEROPTIONS)
Energy Management Advisor
Energy Conservation and Oil Substitution Branch
Energy, Mines and Resources Canada
580 Booth Street
Ottawa, Ontario
K1A 0E4
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